DESYNCHRONIZATION OF EEG FOLLOWED BY PERIODIC APPEARANCES OF ALPHA WAVES AFTER HEAD INJURY. REPORT OF A CASE.

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by

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It is well known that diffuse or localized EEG abnormalities, such as slow waves, reduction in amplitude and seizure discharges, may result from head injuries. Recently an unusual EEG finding was obtained in a case of head injury treated by us. The case will be presented and discussed.

PRESENTATION OF THE CASE

T. W., a 37-year-old man was brought to our hospital by an ambulance in a state of coma at about 2 p. m. on November 27, 1958. About 5 minutes before, he had been driving an auto cycle and, because of wrong driving, had fallen on pavement with instant loss of consciousness. On examination, not only was he unresponsive to calling by the name but also to nociceptive stimuli delivered to any part of the body. His both arms were extended at his side and were conspicuously rigid, whereas rigidity was not marked in legs. Slight stiffness of the neck was also noted. Respiration rate was 20 a minute and pulse rate about 100 a minute. On inspection the head showed no abnormality. The eyes showed right upper conjugate deviation, though they moved occasionally in other directions. The size of the pupil was equal on both sides and reaction to light was normal. Corneal reflex was also normally exhibited. Tendon reflexes were exaggerated bilaterally, but abnormal reflexes were absent. More than one hour after injury he recovered grossly normal consciousness and rigidity of the arms disappeared. General condition also returned to normal, leaving only headache. Cerebrospinal fluid, examined on the next day, was normal, its pressure being 170 mm of water. Carotid angiography, performed on December 3, gave normal finding. When the patient left the hospital on December 4, neurological examination revealed no abnormality and headache had already disappeared. When examined on December 2, 1959 (about a year after the injury) he was healthy subjectively and objectively, except for slight subjective forgetfulness.

EEG examinations were performed 30 minutes, 5 days, 6 days and about a year after the injury.

About 30 minutes after the injury, when the first EEG examination began, the patient was still unconscious but occasionally moved his arms spontaneously, which,

however, were still rigid. Fig. 1 shows an example of the record. Though some

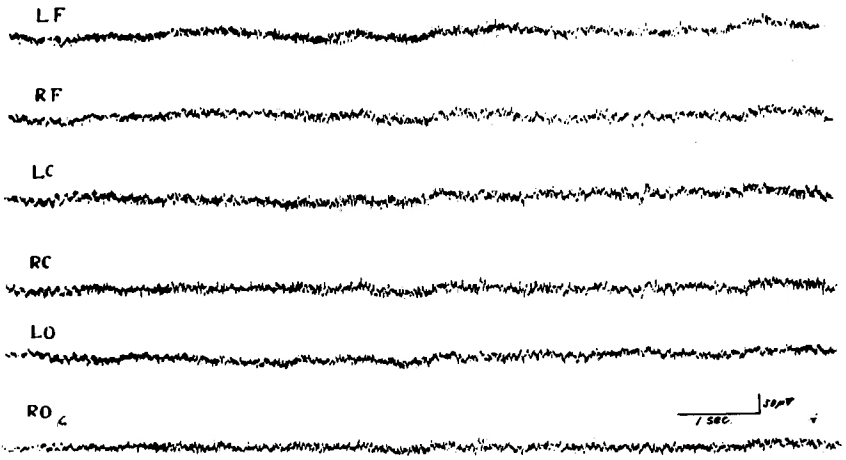

Fig. 1 EEG recorded about 30 minutes after the injury, when the patient was unconscious (Nov. 27, 1958). Explanation appears in the text. EEGs in this and following figures were recorded monopolarly from left frontal (LF), right frontal (RF), left central (LC), right central (RC), left occipital (LO), and right occipital (RO) regions, reference being made to ipsilateral ears. Time scale and calibration are indicated at the right lower corner of each record.

muscle potentials were intermingled, it seemed that dominant activities in the record were low voltage fast waves. Some relatively low voltage alpha and theta activities were also seen. Neither distinct asymmetry nor seizure discharge was observed. As recording went on irregular alpha activities increased gradually. When recording was ended about 50 minutes after the injury, the patient showed faint response to calling by the name and rigidity of the arms was no more conspicuous.

The second EEG examination was made 5 days after the injury. As shown in Fig. 2, the EEG showed periodic burst-like appearances of diffuse 10 p. s. activities.

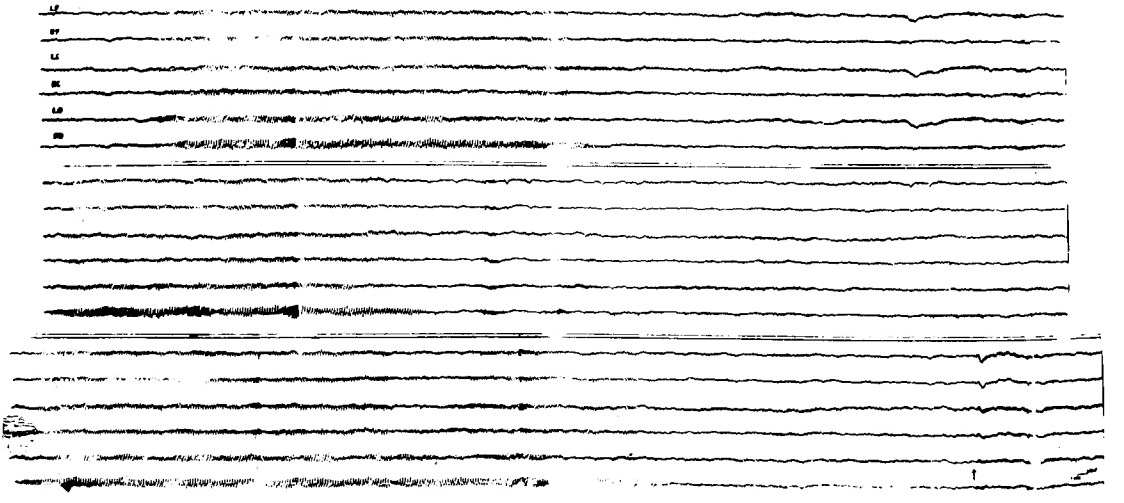

Fig. 2 EEG recorded 5 days after the injury (Dec. 2, 1958). Upper, middle and lower records continue without interruption. At the arrow indicated on the lower record the patient was spoken to and answered. Explanation appears in the text.

The interval periods consisted of low voltage fast activities. Since the 10 p. s. activities were dominant in the occipital region and blocked by opening eyes (Fig. 3),

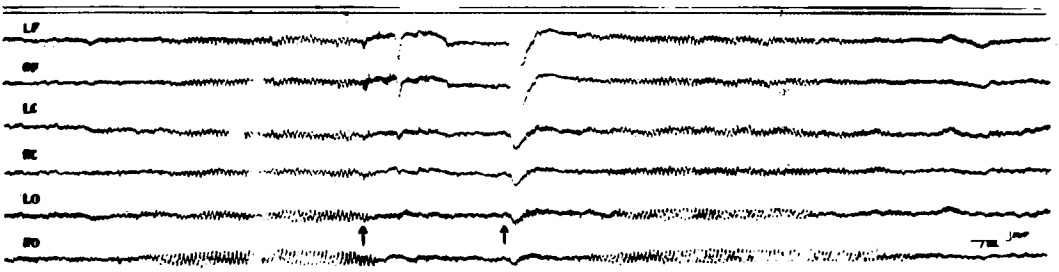

Fig. 3 EEG recorded at the same time as the preceding one. At the first arrow the patient's eyes were opened and at the second one they were closed.

they were definitely alpha waves. The alternations of alpha wave period and desynchronized one were different from the usual waxing and waning phenomenon since the latter was observed independently in alpha wave periods. Occipital alpha waves showed asymmetry, being larger and tending to appear longer on the right side. Duration of the alpha wave period was 7 to 29 seconds, mostly 13 to 21 seconds, while that of desynchronized period was generally 7 to 33 seconds. That this low amplitude record did not indicate drowsiness was apparent on the ground not only of patient's report, but also of the fact that provoking his attention by speaking to did not induce appearance of alpha waves (Fig. 2). According to his report he was not paying attention to something in this period, either. Thus the phenomenon of alternations was based on a quite unconscious process.

The EEG finding obtained 6 days after the injury was quite the same as above.

The EEG recorded about a year after the injury gave following finding. Tendency of periodic appearances of alpha waves was still observed, but the duration

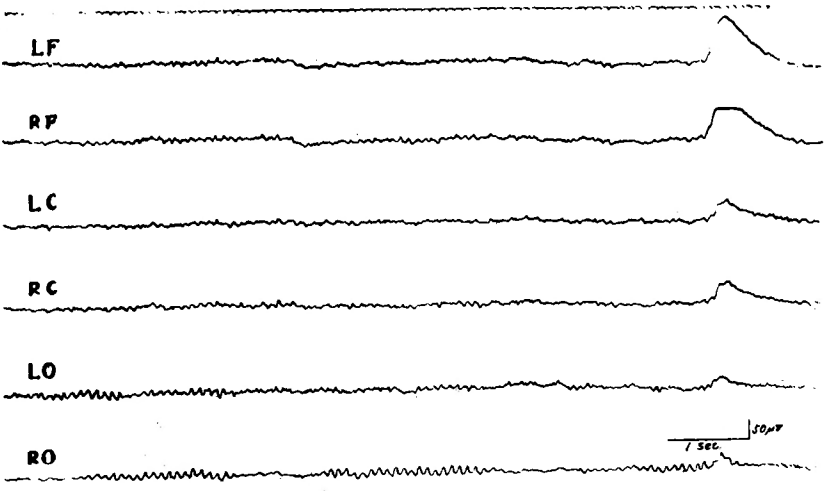

Fig. 4 EEG recorded about a year after the injury (Dec. 2, 1959). Explanation appears in the text.

was generally shorter than in the preceding records, i.e. it was 2 to 20 seconds, mostly 2 to 13 seconds, while duration of the desynchronized period was generally 1 to 28 seconds. Occasionally appearance of alpha waves in nearly normal manner was noted (Fig. 4). Asymmetry of occipital alpha waves was still present.

No apparent seizure discharge was observed throughout those records.

DISCUSSION

Although symptoms observed immediately after the injury, such as rigidity of upper extremities and slight stiffness of the neck, are not typical of cerebral concussion, or commotio cerebri[3], this case may belong to ARAKI's II-type of head injuries, or the type of cerebral concussion[1] in view of the fact that disturbance of consciousness was only transient and recovery to normal state was early and complete.

In EEGs of this case we find two facts of particular interest. The one is that desynchronized EEG accompanied the state of disturbed consciousness immediately following the head injury. The other is the phenomenon of alternations of alpha wave period and desynchronized or beta wave period seen after disappearance of acute symptoms.

The former EEG is also called the activation pattern and it has been clarified by Magoun and associate investigators[8)14)15)] to be induced by excitation of the reticular activating system of the brain stem. On the other hand rigidity of the arms and stiffness of the neck observed immediately after injury—which may be interpreted as a transient decerebrate rigidity (though not typical)—may also suggest irritation of the brain stem[13)]. According to Magoun and associates excitation of the reticular activating system causes desynchronization of EEG together with behavioral arousal or alertness. In contrast desynchronized EEG accompanied unconsciousness in this case. Similar facts, however, have been reported by various investigators[9)10)13)]. Furthermore, one of the authors has clinical as well as experimental experience indicating the possibility that abnormal excitation of the reticular activating system causes desynchronization of EEG accompanied by disturbed consciousness or unresponsiveness[9)17)]. From these considerations and also in view of the fact that the brain stem is liable to receive shear-strains due to rotational acceleration forces in case of head injuries[1)4)11)], it is not undue to suppose that the former EEG finding is suggesting the presence of abnormal excitation of the reticular activating system due to mechanical stimuli.

In regard to the latter EEG finding—alternations of alpha wave and beta wave periods—it appears to have resulted from the injury, not congenitally existed, since recording about one year after the injury revealed a tendency of returning to normal EEG. (As to the asymmetry of occipital alpha waves its relation to the injury is uncertain). What is the mechanism of production of such EEG? It cannot be evidenced practically, but it may not be unreasonable to suppose as follows. It is thought that various modalities of corticipetal[8)18)] and corticifugal[7)12)] impulses are arriving incessantly at the brain stem reticular formation even in a state of rest with eyes closed. This state, showing normal waking rhythm (alpha waves with

waxing and waning) in EEG, may be considered to be a state, in which such impulses as above are modified by appropriate temporal and spatial regulations in the reticular formation and thus are regulating the alpha rhythm generating mechanism[5] in a ballanced manner. Now if such temporal and spatial regulations in the brain stem are impaired traumatically and if excessive discharges and relative exhaustion appear alternately, just as in case of epilepsy, there may occur alternations of desynchronization period and synchronization period in EEG. This may exactly be the situation in the case presented here.

CONCLUSION

EEG finding in a case of head injury was of particular interest in that desynchronized EEG accompanied the state of unconsciousness immediately following the injury, and in that periodic alternations of alpha wave period and beta wave period were observed after disappearance of acute posttraumatic symptoms. Possible causative mechanisms of them have been discussed.

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和 文 抄 録

頭部外傷後脳波の desynchronization 続いて α 波の週期的出現をみた1例

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頭部外傷第Ⅱ型の臨床経過を示した一患者で興味ある脳波所見を得た．それは(1)頭部外傷直後の意識障害時に脳波の desynchronization を認めたこと及び(2)臨床症状の消退後に α 波の週期的 burst 様出現を示したことである．前者は恐らく機械的刺激による脳幹網様賦活系の異常興奮によるもので，後者は外傷による同系の temporal and spatial regulations の障害に起因するものと想像される．